Claims

We claim:

1. A method for modeling interactions between a plurality of models, comprising:

generating a first adaptively sampled distance field having a first spatial hierarchy for a first model, and generating a second adaptively sampled distance field having a second spatial hierarchy for a second model;

determining a potential overlap region, during a time step, using the spatial hierarchies of the first and second adaptively sampled distance fields; and

generating, only when the potential overlap region is non-empty, a third adaptively sampled distance field from the first and second adaptively sampled distance fields using a first interaction procedure and first properties and generating a fourth adaptively sampled distance field from the first and second adaptively distance fields using a second interaction procedure and second properties to model the interactions between the first and second models.

2. The method of claim 1 wherein the interaction procedures are identity procedures so that the first and third adaptively sampled distance fields are identical, and the second and fourth adaptively sampled distance fields are identical.

3. The method of claim 1 further comprising:

intersecting the third adaptively distance field and the fourth adaptively sampled distance field to generate a fifth adaptively sampled distance field representing a non-empty overlap region.

4. The method of claim 3 further comprising:

determining interaction forces from the fifth adaptively sampled distance field.

5. The method of claim 3 further comprising:

sampling surface cells of the fifth adaptively sampled distance field to determine impact forces at a surface of the fifth adaptively sampled distance field.

6. The method of claim 3 wherein the fifth adaptively sampled distance field represents a volume, and further comprising:

sampling the volume of the fifth adaptively sampled field to determine impact forces throughout the volume of the fifth adaptively sampled distance field.

7. The method of claim 3 further comprising:

determining impact forces at a surface of the fifth adaptively sampled distance field by analytic means.

8. The method of claim 3 wherein the fifth adaptively sampled distance field is volumetric, and further comprising:

determining impact forces throughout a volume of the fifth adaptively sampled distance field by analytic means.

9. The method of claim 3 further comprising:

determining a force vector F_B acting on the fourth adaptively distance field due to the penetration of the third adaptively distance field by the fourth adaptively distance field by the sum of forces $\mathbf{f}_{Bi} = k_A(\mathbf{x}_i) * dist_A(\mathbf{x}_i) * g_A(\mathbf{x}_i)$, where $k_A(\mathbf{x})$ is a material stiffness of the third adaptively distance field at $\mathbf{x}$, $dist_A(\mathbf{x})$ is a closest

distance from **x** to the surface of the third adaptively distance field, and $g_A(\mathbf{x})$ is a normalized gradient vector of the third adaptively distance field at **x**; and

determining a force vector F_A acting on the third adaptively distance field due to the penetration of the fourth adaptively distance field by the third adaptively distance field by the sum of forces $\mathbf{f}_{Ai} = k_B(\mathbf{x}_i) * dist_B(\mathbf{x}_i) * g_B(\mathbf{x}_i)$, where $k_B(\mathbf{x})$ is a material stiffness of the fourth adaptively distance field at **x**, $dist_B(\mathbf{x})$ is a closest distance from **x** to the surface of the fourth adaptively distance field, and $g_B(\mathbf{x})$ is a normalized gradient vector of the fourth adaptively distance field at **x**.

10. The method of claim 9 wherein k_A and k_B are identical.

11. The method of claim 9 wherein k_A and k_B are different.

12. The method of claim 9 wherein the deformation due to the force vectors F_A and F_B are volume preserving.

13. The method of claim 1 wherein the first interaction procedure is a deformation procedure to deform the first adaptively sampled distance field and the second interaction procedure is a deformation procedure to deform the second adaptively sampled distance field according to first and second material properties of the first and second models respectively.

14. The method of claim 13 wherein the deformation procedures combine distance values of the first and second adaptively sampled distance fields at a plurality of locations in the first and second adaptively sampled distance fields.

15. The method of claim 1 further comprising:

offsetting the first and second adaptively sampled distance fields to determine a relative proximity of the first and second models.

16. The method of claim 1 wherein the time step depends on a frame rate to animate the interactions between the plurality of models.

17. A method for modeling interactions between a plurality of models, comprising:

generating a first adaptively sampled distance field having a first spatial hierarchy for a first model, and generating a second adaptively sampled distance field having a second spatial hierarchy for a second model; and

determining a potential overlap region, during a time step, by comparing distance values stored in the spatial hierarchies of the first and second adaptively sampled distance fields.

18. The method of claim 17 wherein each spatial hierarchy includes surface cells at leaf nodes of each spatial hierarchy, and further comprising:

comparing distance values of the surface cells of the leaf nodes to determine an exact overlap region.